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AN ALGORITHM FOR COMMODITY DISTRIBUTION AMONG TWO KINDS OF TRANSPORTS POSSIBLY TO BE USED IN THE SILISTRA REGION PROJECT

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AN ALGORITHM FOR COMMODITY DISTRIBUTION AMONG TWO KINDS OF TRANSPORTS POSSIBLY TO BE USED IN THE SILITRA REGION PROJECT

This algorithm is a modified Ford-Fulkerson method for the shortest distance in a set, in which the transformed transportation costs are used instead of the transportation distance. For this purpose a set of commodity destinations serves as a basis for sketching of the sections and crosspoints of the two transports. It is supposed that there is no friction limitation and the initial, final, surcharge and transit operation expenditures are assigned.

Statement of the task:

- the initial and final points of the commodities transported are known;
- an alternative for one of the two transports may be used;
- during the transportation process the commodities may be surcharged from one to another mode of transport;
- it is necessary that the two transport participation be defined with the aim of obtaining minimum transformed costs.

For this purpose the following method of sketching the transportation set is chosen:

- each subregion of the region is subdivided into two crosspoints (expressing two kinds of transports);
- the sections between the different subregion crosspoints have a value equal to the transportation costs per one ton transported through the given section (i.e. by given transport);
- the sections within the subregion (i.e. between the two transports) have a value equal to the surcharge costs from one to another transport.

The total volume of commodities transported by the two transports is derived by means of sequent summing of the separate commodities.

The procedures are the following:

- the "distance" of the crosspoint is D_i (i = crosspoint number; the initial crosspoint is $D_{io} = 0$);
- the following inequality has to be checked:

$$D_i + p_{ij} < D_j \quad , \tag{1}$$

where:

p_{ij} = distance of the sections between i and j.

In the case when this condition is satisfied, one can give a value of:

$$D_j = D_i + p_{ij} \quad ; \tag{2}$$

- the above condition has to be repeated until this inequality is fulfilled for all crosspoints.

This algorithm was used in Bulgaria at the Institute for Complex Transport Problems but in a different way: after each iteration the following inequality has been verified:

$$A_j^{(m)} > A_i^{(m)} + P_{ij} \quad , \tag{3}$$

where:

$A_l^{(t)}$ = potential of l-th apex at t iteration;

P_{ij} = "price" of section i, j.

At the initial iteration potential $A_j = \infty$ is given to all apexes (except io). If the above inequality is fulfilled at the following iteration for some apex j, one gives a potential to this:

$$A_j = A_i + P_{ij} \quad . \tag{4}$$

After all the sections going out of the i-th apex are checked, its indication can be excluded. This process continues until such interactions exist. In this sense the sections i, j taking part in (4) express the lowest expenditures of the trasported commodities.

If the subsequent number of the apex of the line is i, it can be derived from the sequent of denoted apexes, which have a potential $A_j = \infty$ and which are changed with (m_j) or the m-th apex with i(m). Therefore, i(1) is always equal to io. These apex indications keep their place by the end of the task procedure.

The sequence of the apex review is the following:

If the apex i with m_i indication is treated and some of the apex potentials jl are changed, the following apex to be treated is not i + 1, but:

$$\beta = \min_{(jl)} [m(jl), m(i) + 1] \quad . \tag{5}$$

This procedure can be illustrated inthe following way:

Let in the apex line under analysis some of the apex potentials denoted with $(\hat{})$ are changed:

$$io, \ldots, \hat{in}, in+1, \ldots, \hat{il}, \ldots, \hat{ip}, ip+1, \ldots, \hat{is}, \ldots, ih \quad . \tag{6}$$

The solution is reached when $\beta = M + 1$.

The formal description of this algorithm is as follows:

Notations:

l = number of the last apex in the line;

p(i) = number of the apex in the line, following the i-th apex;

q(j) = number of the crosspoint preceeding the j apex in the shortest way;

δ(j) = indication of the apex;

i = number of the treated apex.

I. All apexes receive potentials:

$$A_i := \infty \text{ and } \delta(i) := p(i) := 0.$$

II. $A_{io} := 0$, $\quad$ i: = l: = i 1.

III. For the successive section (i,j) the equation (4) has to be verified. It it is breached, one has to go to VIII, otherwise, to (4).

IV. If $A_j = \infty$, hence $p(l) := j$ and $l := j$ and the transition is to VI. If $A_j \neq \infty$, the transition is to V.

V. If $\delta(j) = 0$, hence $p(j) := p(i)$, $p(i) := j$ and the transition is to VI. If $\delta(j) \neq 0$, the transition is to VII.

VI. $\delta(j) := 1$.

VII. $A_j := A_i + P_{ij}$; $q(j) := i$.

VIII. If the section (i,j) is the last section, the transition is to IX, otherwise, to III.

IX. If $p(i) \neq 0$, hence $T := i$, $i := p(i)$, $p(s) := \delta(s) := 0$ and the transition is to III. If $p(i) = 0$, the procedure is finished.

In this algorithm the annual transformed transportation costs are used as a measure for the transported commodities which makes two kinds of transports commensurable. The annual transformed transportation costs are calculated on the following methodological basis:

- the transportation costs are divided by main elements of the transportation process, referring to one ton for initial, final, surcharge and transit operations and referring to one ton per kilometer for movement operations;
- in the transformed costs the current transportation costs and capital investments are included;
- the costs calculation are made by different commodities, taking into account their feature characteristics: the vehicle used, the carrying capacity, machinery used, etc.

The following step of the investigations in this direction could be to elaborate an algorithm for commidity distribution among more than two kinds of transports.